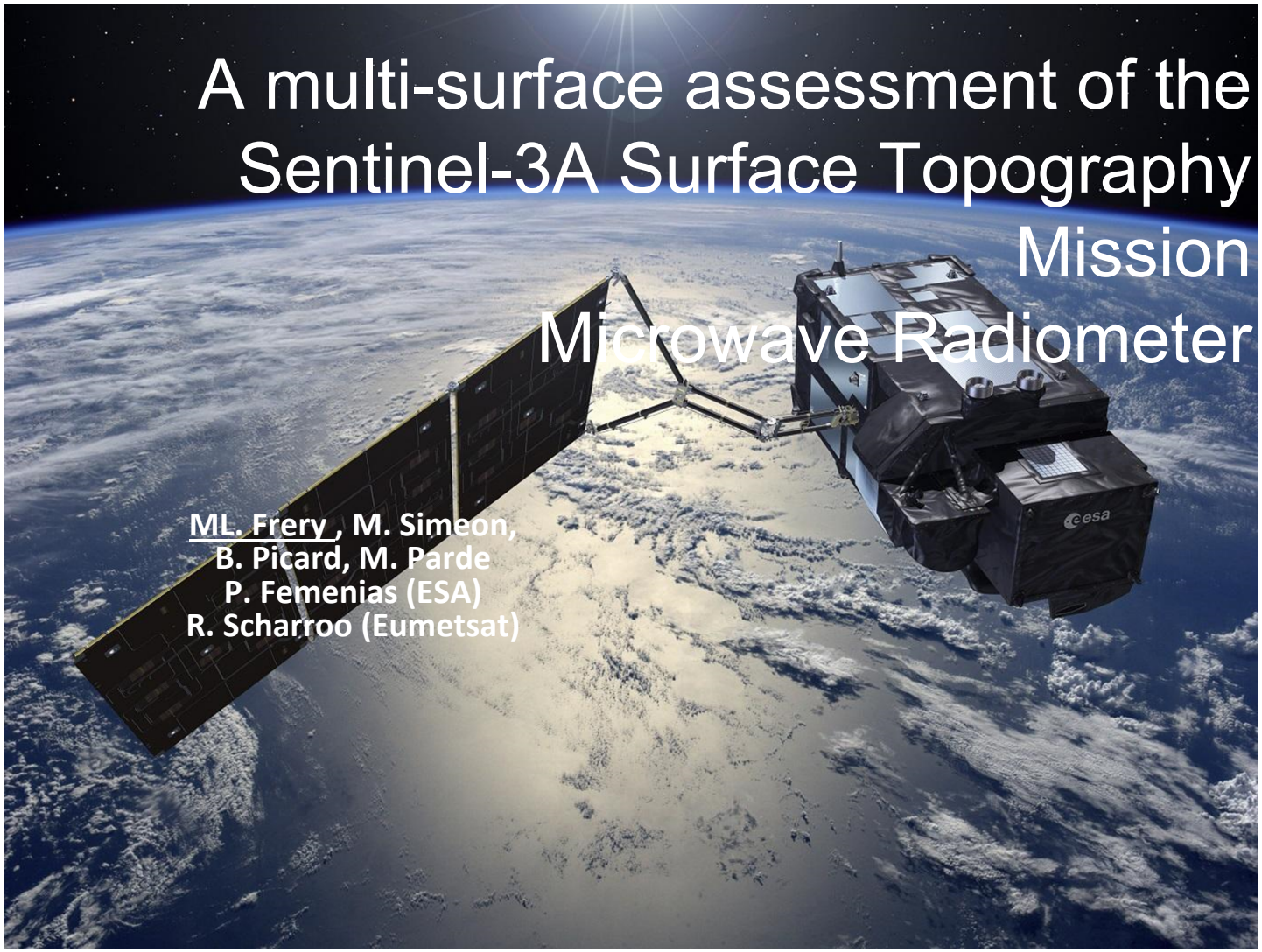
A multi-surface assessment of the Sentinel-3A Surface Topography Mission Microwave Radiometer



ML. Frery , M. Simeon,
B. Picard, M. Parde
P. Femenias (ESA)
R. Scharroo (Eumetsat)

Overview

- Instrument stability over ocean and Amazon forest

Sentinel-3 MWR very good performances lead the path to multi-surface studies:

- Coastal areas
- Hydrological areas
- Sea ice

MWR status

Long term monitoring

Comparison to other radiometers (J2,J3, AMSU-A, SARAL), 5 instruments monitored on a daily basis

Coldest ocean points

- Low winds, no clouds, minimal water vapor
- Statistical selection of coldest ocean TB over ocean
- Method developed by Ruf and updated by Eymard to detect and monitor drifts

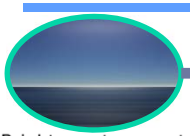
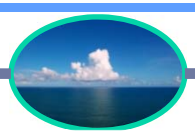
Simulations (single & double difference)

- Single difference: remove the impact of the instr. conf. & geophysic
- Double difference: assess the calibration difference between two radiometers

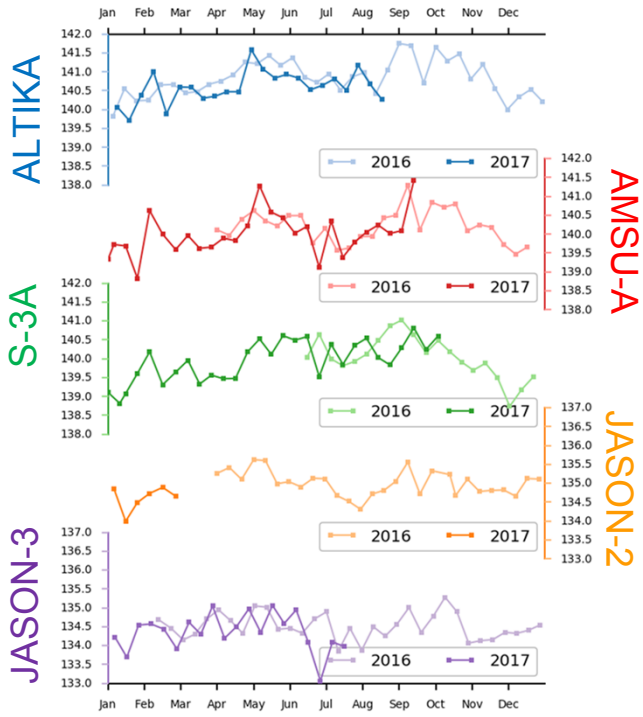
Amazon forest

- Naturel target closest to a black body
- Weak dependency with the frequency, polarisation and incidence
- Editing and average of measurements over evergreen forest

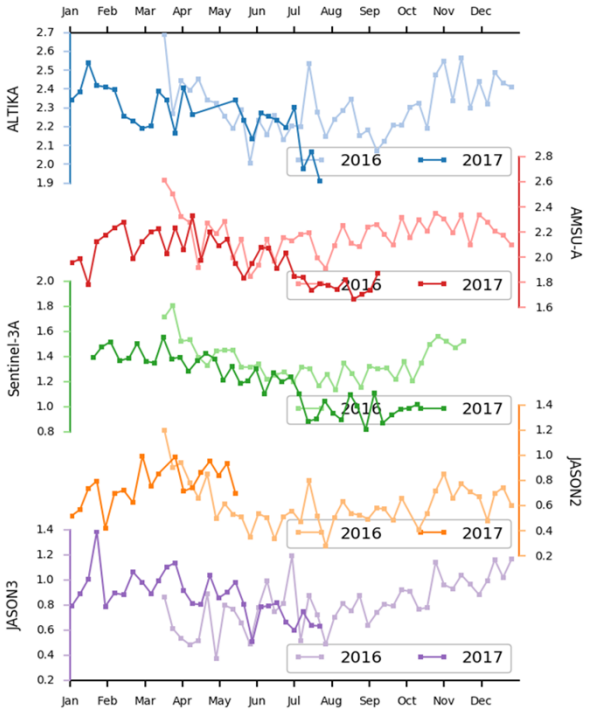
Long term monitoring – 23.8GHz

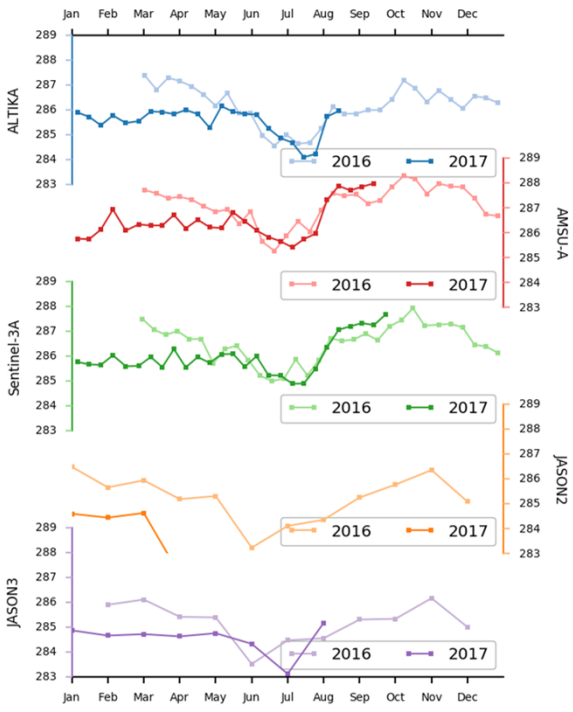

Coldest ocean Brightness temperature (23.8GHz)



Single difference (MWR-simu) (23.8GHz)

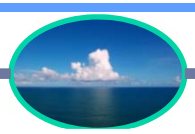


Amazon forest hottest Brightness temperature (23.8GHz)

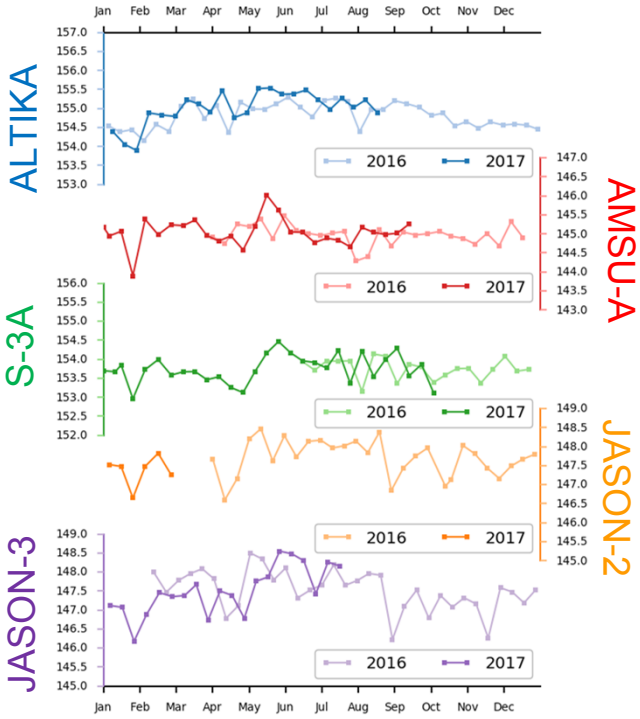


⇒ Good stability of S3A MWR since beginning of the mission

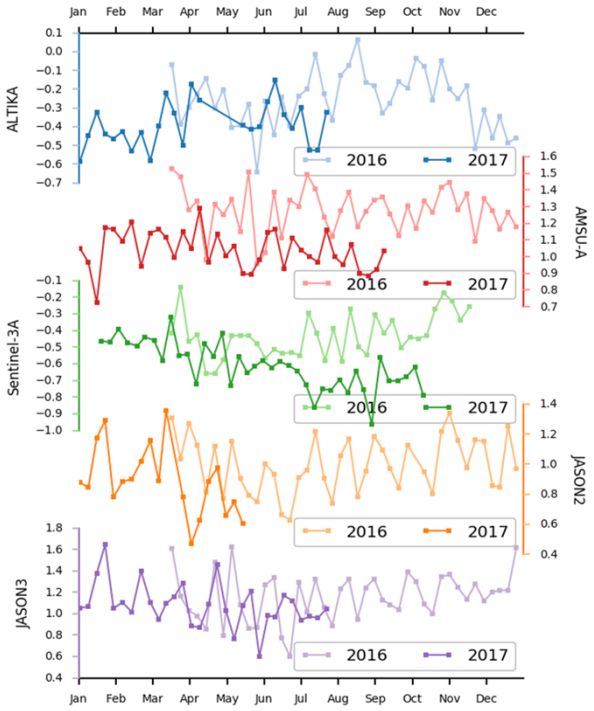
Long term monitoring – Liquid water channel

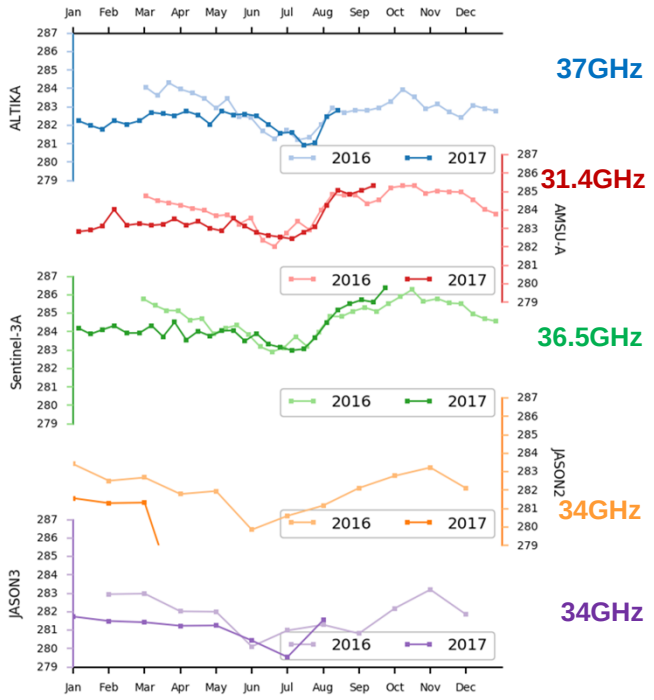

Coldest ocean Brightness temperature (Liquid water channel)



Single difference (MWR-simu) (Liquid water channel)



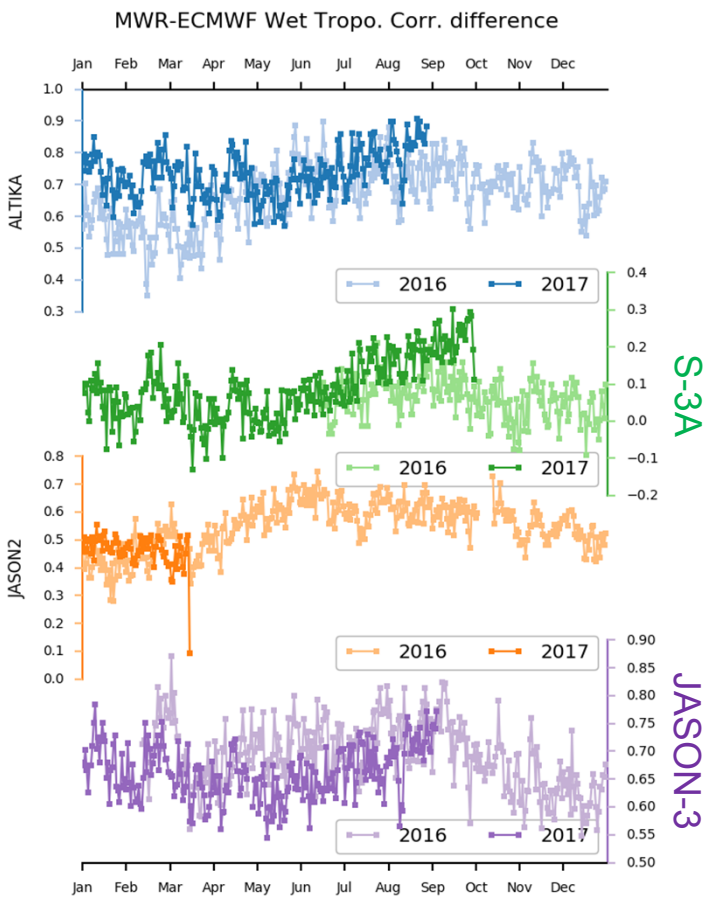
mazon forest hottest Brightness temperature (Liquid water channel)



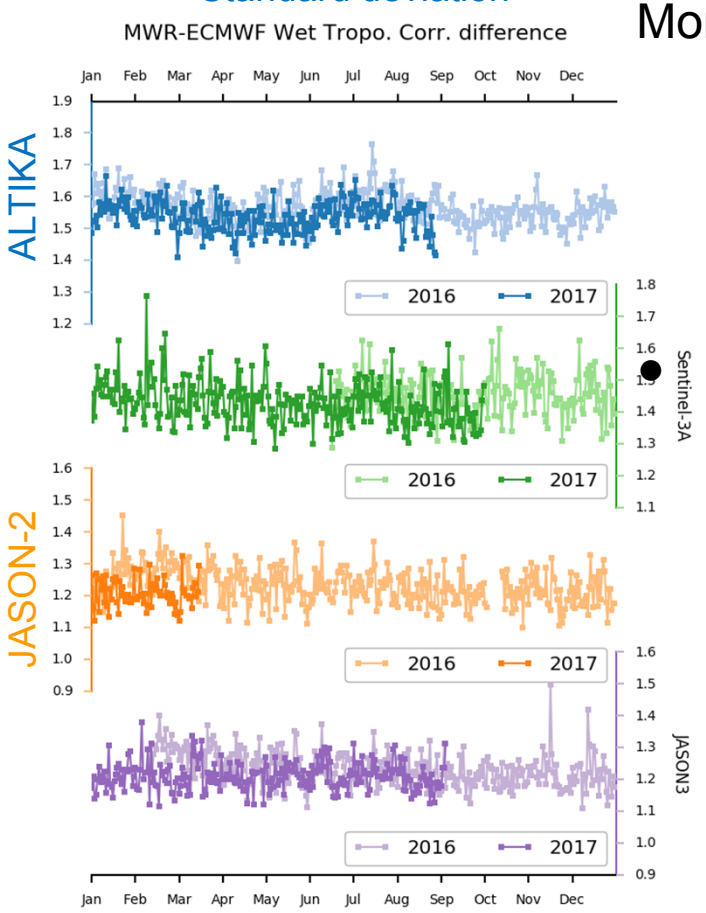
⇒ Good stability of S3A MWR since beginning of the mission

Wet tropospheric correction

Mean/day



Standard deviation



Monitoring difference between radiometer and ECMWF WTC for stability and performances:

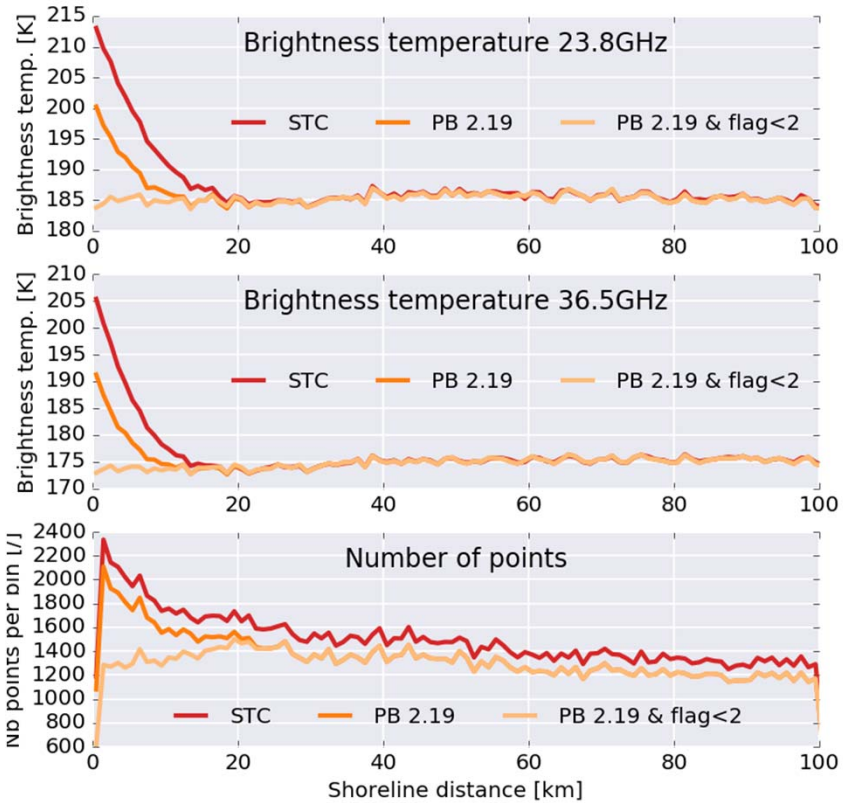
<u>good stability and performances of S3A</u>

Coastal areas

New interpolation dedicated to coastal areas

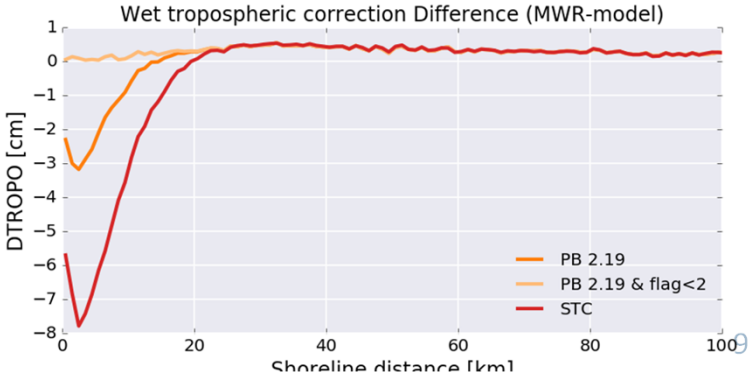
Available soon in the products

July?August 2017 ~1 cycle



- updated interpolation scheme selecting non contaminated data or extrapolate latest valid ocean TB up to the coast (FLAG = 0 || 1)
  => the contamination is reduced
- sometimes, the latest valid ocean TB is too far (due to coastal configuration) (FLAG = 2)
- User can select FLAG < 2 for even better performances (at the cost of less measurements available)

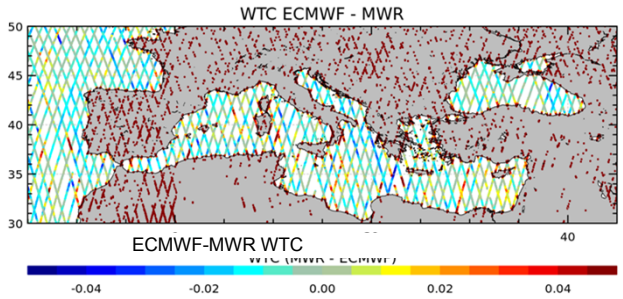
Along-track interpolation flag
0 : Nominal
1 : Extrapolation
2 : degraded
3 : failed

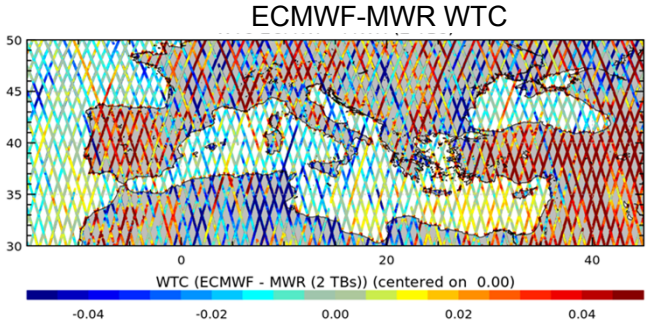


New retrieval dedicated to coastal areas

- Following study presented on Coastalt altimetry workshop (Florence,2017)
  - Application of empirical retrieval algorithm (2*TBs)

Official algo (Ocean)

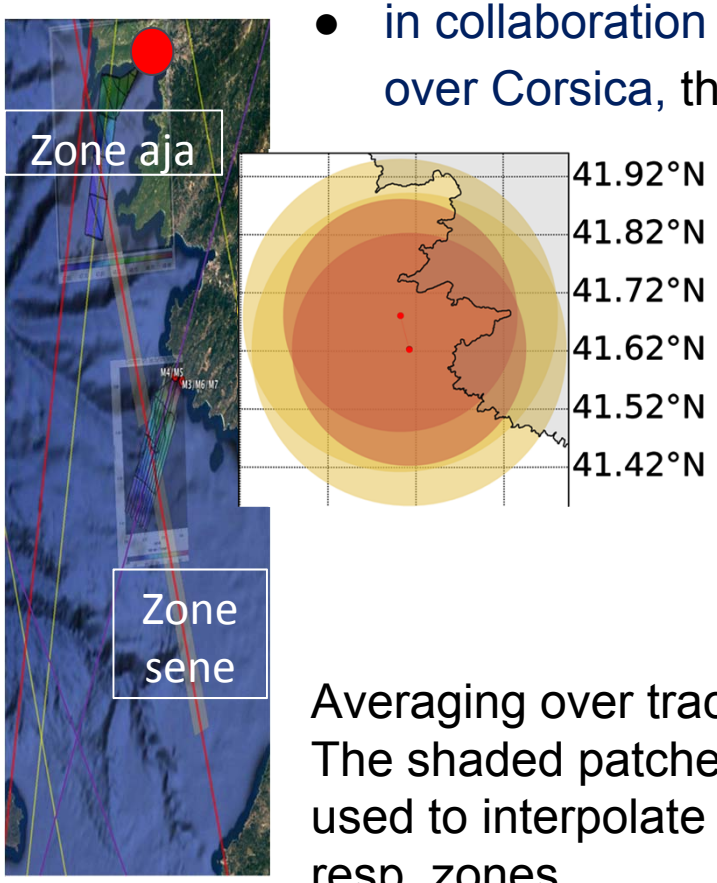




Empirical 2*BTs

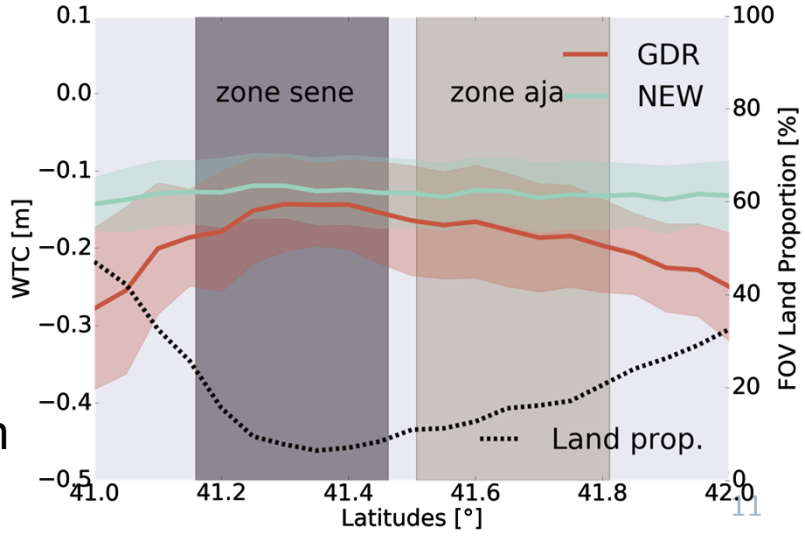
- Learning: measurements =>TB(x2) + sigma0 **over Mediterranean Sea**
- Benefits for coastal areas:
  - NN will learn contaminated measurements
- adding additional information on contamination increases performance
  - Learning: measurements =>TB(x2) + sigma0 + FOV land prop. **over Med. Sea**

Ajaccio, Corsica



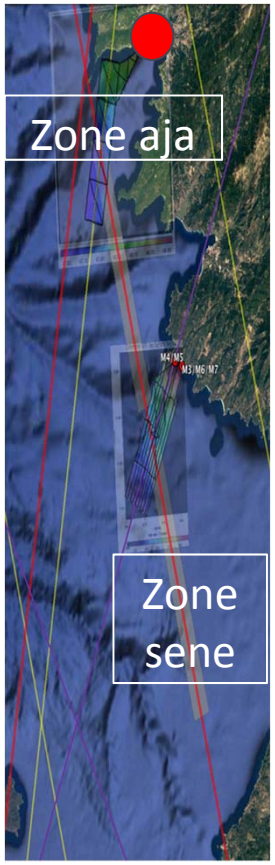
- in collaboration with P. Bonnefond (ObsPM) O. Laurain (GeoAzur) over Corsica, the « aja » and « sene » zones for validation

The 23.8 GHz and 36.5 GHz 2.5xTheta3dB used for LandFraction computation



Averaging over track 741
The shaded patches are the regions used to interpolate the WTC used on resp. zones

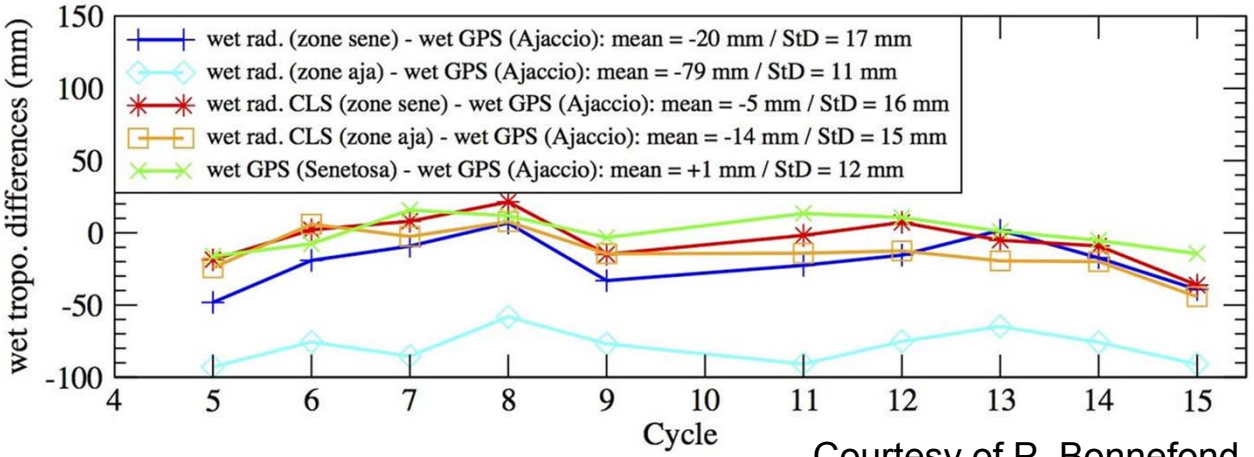
Ajaccio, Corsica



Validation against Ajaccio GPS (P. Bonnefond, O. Laurain)

The GPS is located by the red dot M1 (AJA) on the top of the figure.

- **the bias is reduced with the new solution**
- the stdev is similar with the new solution over sene zone
- the stdev is larger with the new solution over aja zone



Courtesy of P. Bonnefond

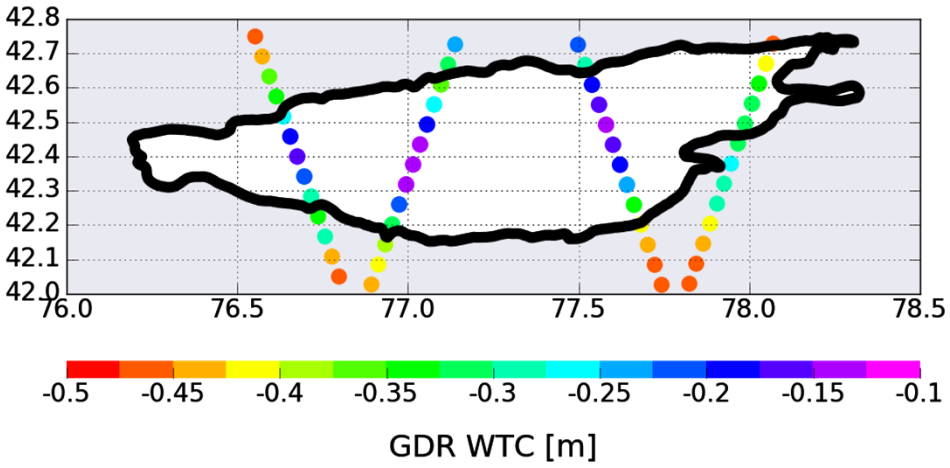
Hydrology

New retrieval dedicated to hydrology

- NEW WTC based on Neural Network
- Learning: measurements =>TB(x2) + sigma0 **over lake**
- Benefits for hydrological areas:
  - NN will learn contaminated measurements
- adding additional information on contamination increases performance
  - Learning: measurements =>TB(x2) + sigma0 + FOV land prop. **over lake**

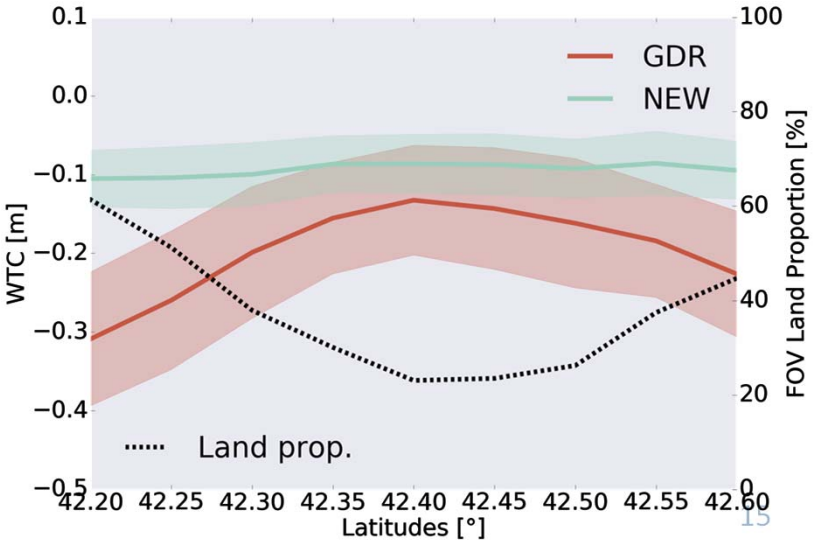
- in collaboration with JF Crétaux (LEGOS) over Issyk-kul Lake

Issyk-Kul Lake



The current WTC (GDR) is contaminated by land and thus correlated to the LF. Even in the middle of the lake, the closest coastline is at about 25 km, at the limit of the land contamination.

Averaging over all the tracks against latitudes from June 2016 to April 2017 **The dedicated WTC is not impacted by the land contamination.** Even the measurements near the coastlines are now physically meaningful.



Sea Ice

First steps on Sea Ice

Study based on the method proposed in the paper

Hermozo et al 2016: "Modeling Sea Ice Surface Emissivity at Microwave frequencies: Impact of the surface assumptions and Potential use for sea ice extent and type classification" (IEEE TGRS)

➢ A good knowledge of emissivity is required to improve assimilation of window channels over sea ice surfaces
➢ Large uncertainties on surface temperature and type of surface scattering remains
➢ **Influence of type of surface scattering : flat specular reflection or rough Lambertian scattering**
➢ Spec - Lamb emissivity difference is maximized for near-nadir observations

Methodology:

➢ Computation of emissivities using two BTs S3A (23.8GHz, 36.5GHz) (data from cycle 6 to cycle 16 from reprocessing) and ECMWF analyses using Radiative TM
➢Two assumptions of surface scattering: specular and lambertian
➢Filtering of clouds using ECMWF cloud liquid water content

Annual variability

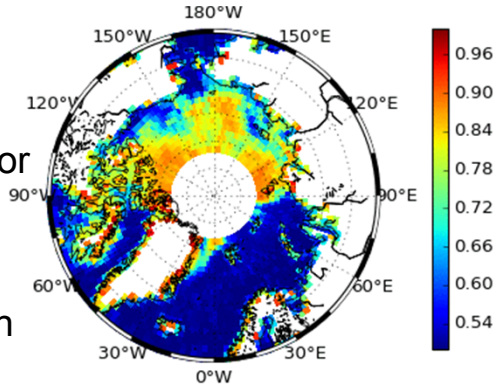
Sentinel-3A Cycle 6 (2016-06-28 / 2016-07-25)

➔ Same pattern and order of magnitude than Hermozo et al. For SpecEmiss36 et DiffEMiss36

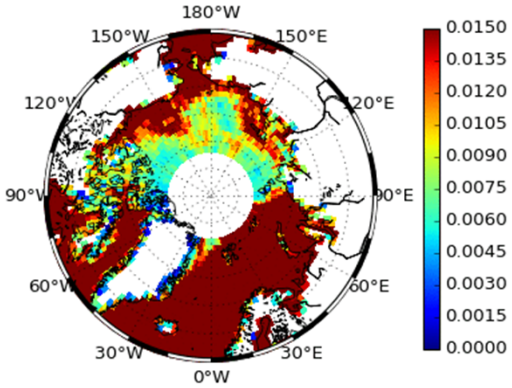
➔Clear distinction between open ocean and sea ice for DiffEmiss36

➔GR23-36 =ΔTB/ΣTB provides information on the surface

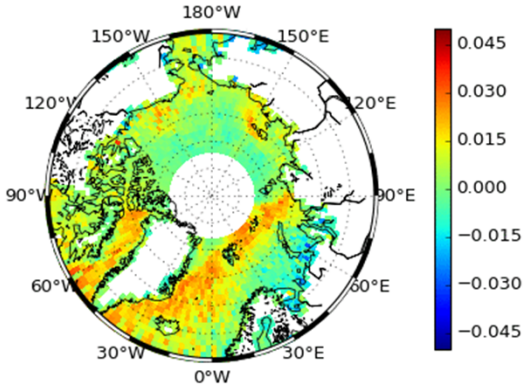
Spec Emiss 36



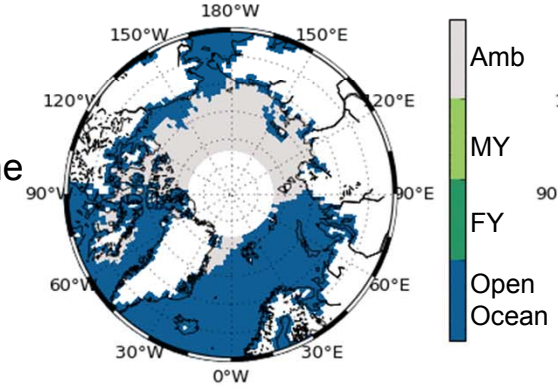
DiffEmiss 36



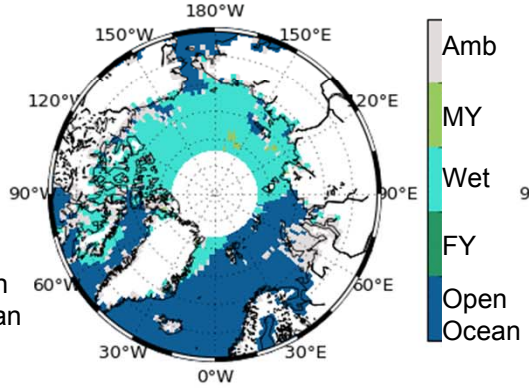
GR23-36



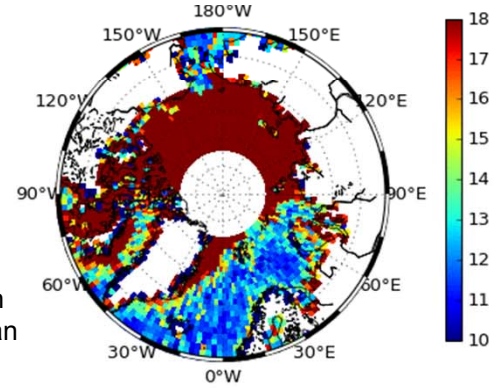
OSISAF ice type



S3 sea ice flag



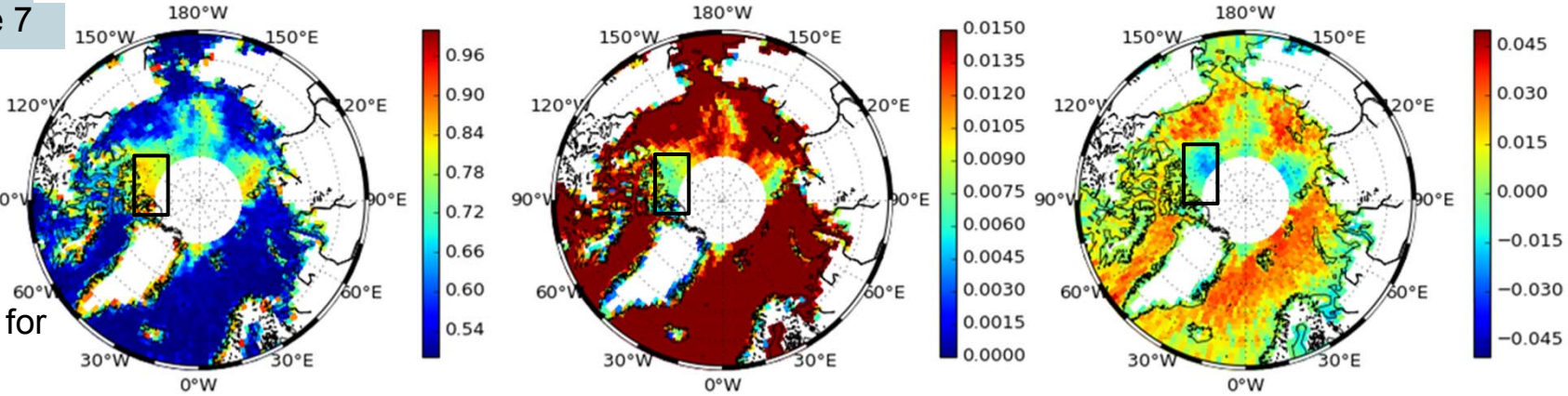
Sigma0 (SAR)



Summer vs Winter

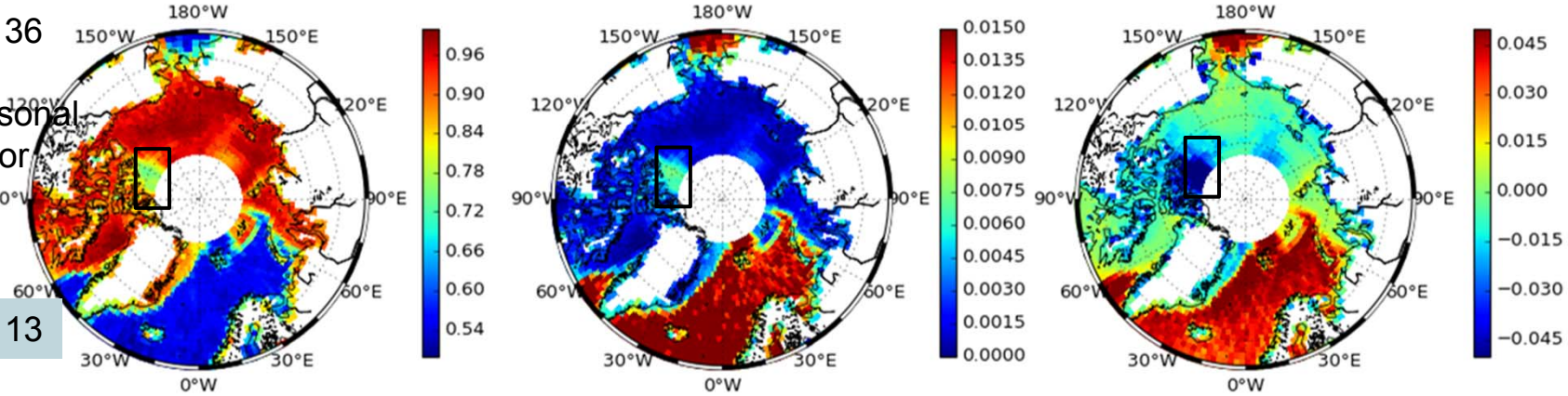
Spec Emiss 36 | DiffEmiss 36 | GR23-36

S3A Cycle 7



MY ice
Small seasonal variations for Emiss36 and DiffEmiss 36

Clear seasonal variation for GR23-36

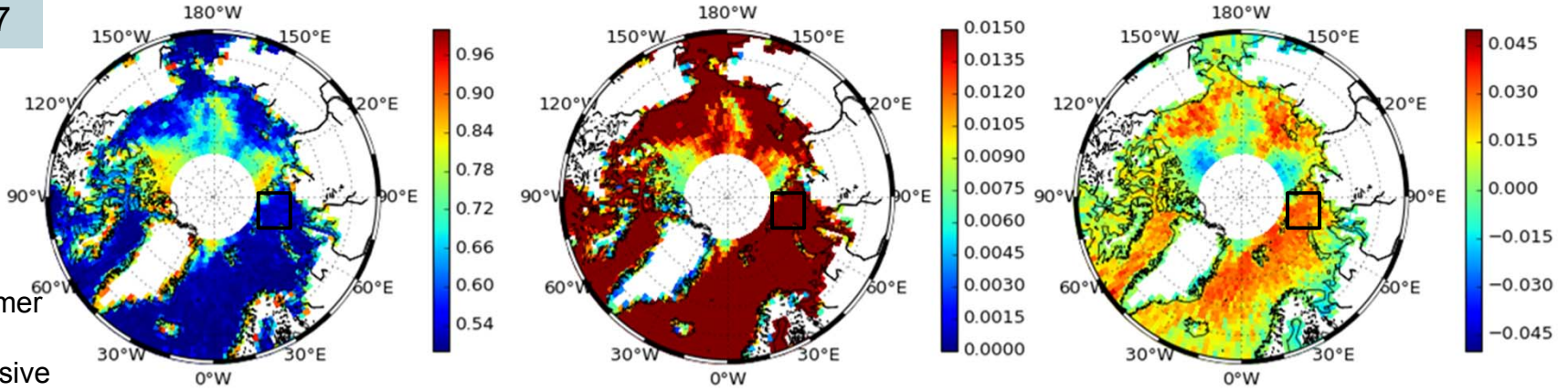


S3A Cycle 13

Summer vs Winter

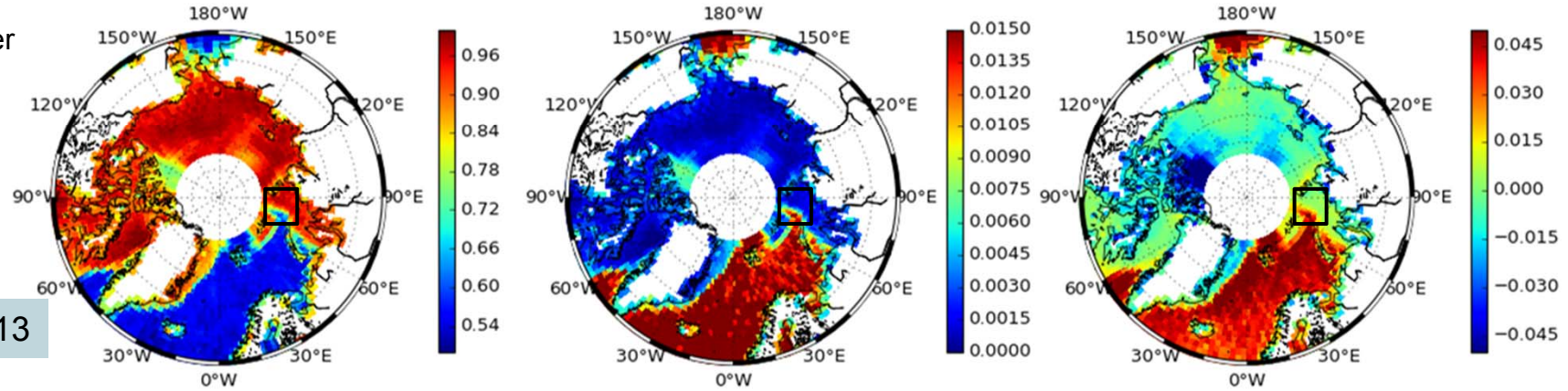
Spec Emiss 36 | DiffEmiss 36 | GR23-36

S3A Cycle 7



FY ice
Open water during summer

Highly emissive ice surface during winter

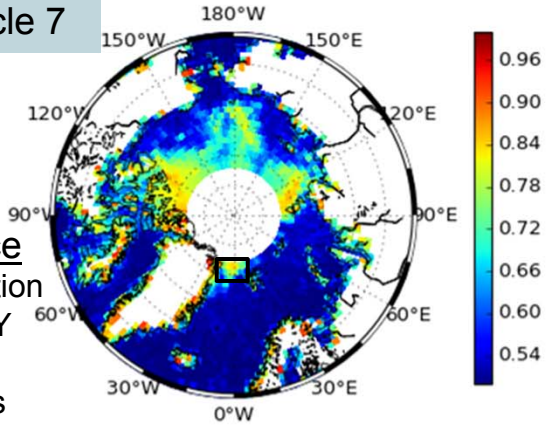


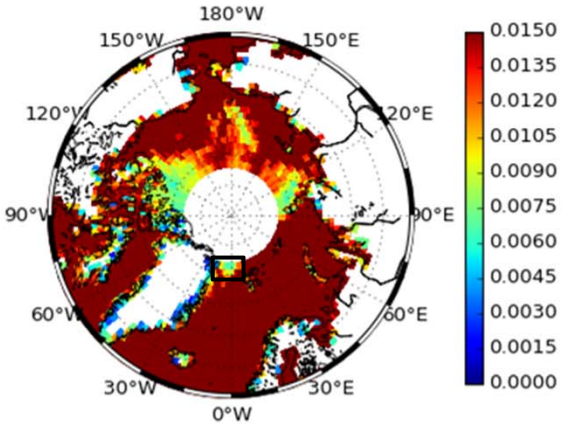
S3A Cycle 13

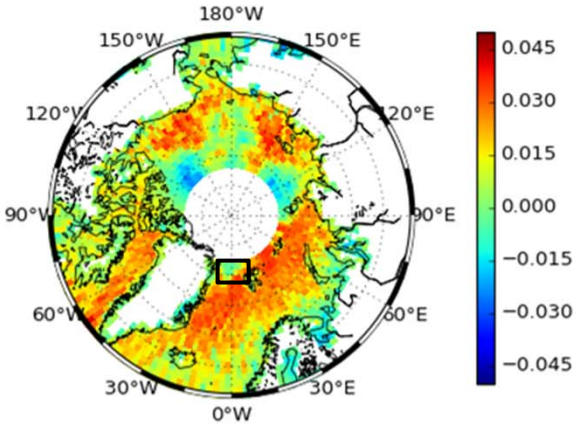
Summer vs Winter

Spec Emiss 36 | DiffEmiss 36 | GR23-36

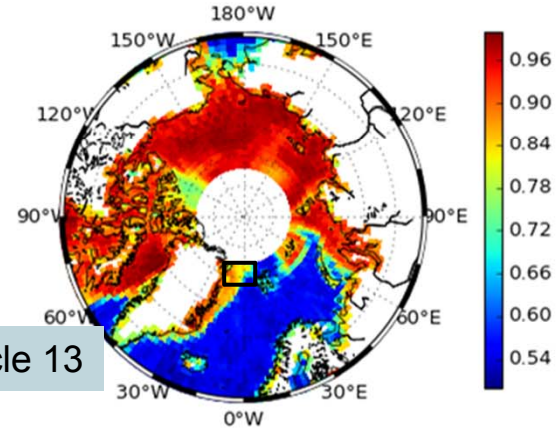
S3A Cycle 7

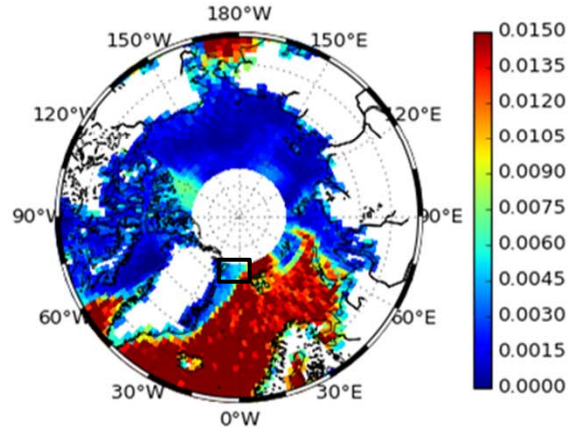


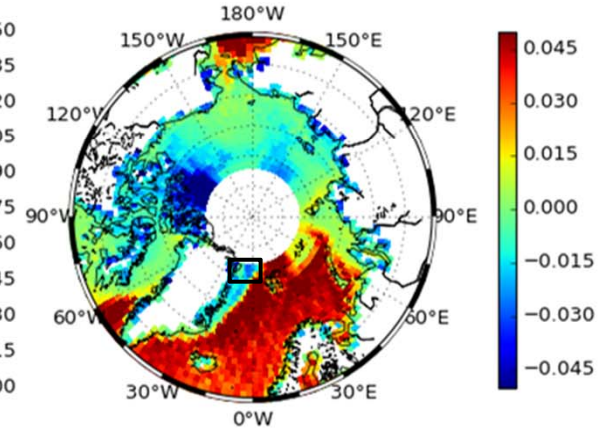




Mixed ice
Combination of both FY and MY properties







S3A Cycle 13

Conclusions

Overview of MWR performances :

- Good stability of MWR instrument: the instrument is performing well
- Good performances, similar to other instruments

Towards improved/dedicated MWR products:

New fields of investigation / improvements

Coastal areas

- Land Contamination of MWR pixels from 23 km/16 km from the shoreline for 23.8GHz/36.5GHz respectively
- A new interpolation scheme will be soon available to improve the retrieval of WTC close to the coast

Conclusions

Overview of MWR performances :

- Good stability of MWR instrument: the instrument is performing well
- Good performances, similar to other instruments

Towards improved/dedicated MWR products: New fields of investigation / improvements

Hydrology

- Same issue of land contamination than coastal areas
- Empirical algorithm improves retrieval of WTC over lake Issyk-kul
- Validation on-going
- Same approach is applicable to coastal areas

Sea ice

- Emissivities computed at MWR frequencies using MWR measurements over sea ice
- First results show consistent results (patterns and order of magnitude) with literature
- Study only beginning

THANKS FOR YOUR ATTENTION